PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : B27L 11/00

A1

(11) International Publication Number: WO 99/58310

(43) International Publication Date: 18 November 1999 (18.11.99)

(21) International Application Number: PCT/FI99/00376

(22) International Filing Date: 5 May 1999 (05.05.99)

(30) Priority Data:
981033 8 May 1998 (08.05.98) FI

(71) Applicant *(for all designated States except US)*: SUNDS DEFIBRATOR WOODHANDLING OY [FI/FI]; PI 210, FIN-28101 Pori (FI).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: JONKKA, Arvo [FI/FI]; Mäntykatu 20, FIN-28430 Pori (FI).

(74) Agent: RUSKA & CO. OY; Runeberginkatu 5, FIN-00100 Helsinki (FI).

(81) Designated States: BR, CA, ID, US, ZA, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

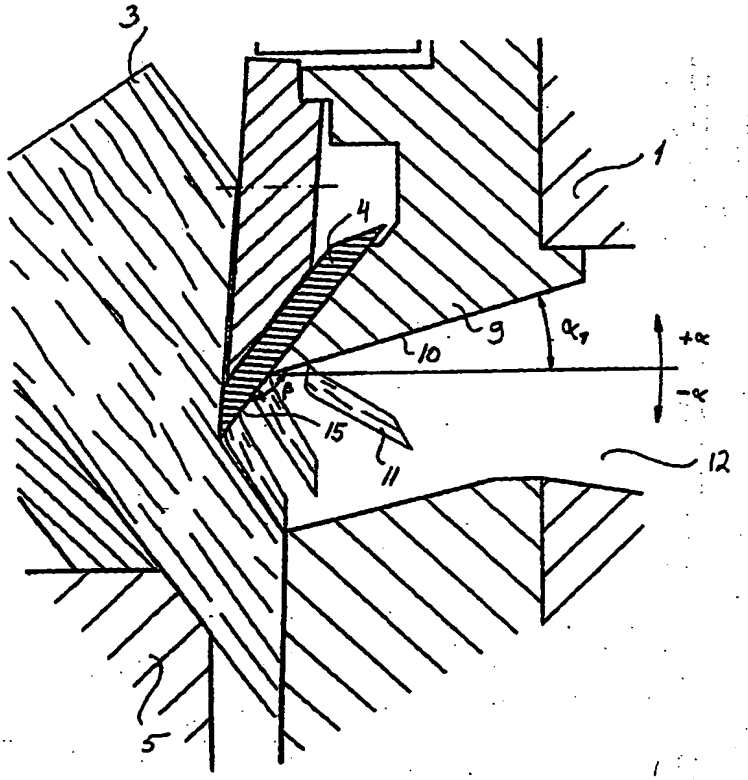
Published
With international search report.

Prior Art

(54) Title: A METHOD FOR CHIPPING OF WOOD AND A DISC CHIPPER

(57) Abstract

A wood chipping method and a disc chipper provided with knives (4). The chips (11), after having separated from a log (3), pass through a chip opening (12) in the disc (1) and hit an impact surface (10) located after a knife. Along different portions of the knife (4), a stronger impact effect is caused in proximity to the centre than in proximity to the outer periphery of the disc. The direction of the impact surface (10) deviates more from the direction of the rear surface (15) of the knife in proximity to the centre of the disc than in proximity to the outer periphery of the disc. The distance of the connecting line between the rear surface (15) of the knife and the impact surface (10) from the cutting edge (16) of the knife can be longer on the outer periphery of the disc than in the centre of the disc.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece			TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	NZ	New Zealand		
CM	Cameroon			PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

A METHOD FOR CHIPPING OF WOOD AND A DISC CHIPPER

Wood chips used in the paper and pulp industry are presently produced mainly by means of disc chippers developed for chipping of large amounts of wood. One disc chipper known in the art is described in published application FI 91946. Chipping results show that disc chippers can produce chips of very high quality. With a good chipper the share of the accepted fraction should be about 90 %. According to tests a result like this is easy to obtain in test chipping by using a suitable chip length and chipping speed. Even production chippers of big size and with a uniform wood quality and capacity can obtain these values.

However, under normal manufacturing conditions the different factors which the chip quality depends on, like the diameter of the logs, the amount of wood to be chipped and the dry solids content of the wood, vary constantly. The main problems related to chipping by means of a disc chipper are in that the amount of sawdust and pin fractions (fine fractions) increases when the amount of oversize and overthick chips (coarse fraction) is reduced. (In the chip size distribution analysing method SCAN-CM 40:94 the chips are distributed into oversize, overthick, accepted, pin and sawdust fractions).

The chippers known in the prior art perform the chipping mostly in the centre of the chipper knives, and the object has been to provide the best chipping conditions in the centre of the knives in order to maximize the quality of the chips. However, the "scissors force" and/or the cutting force the knives moves/move the logs closer to the centre of the disc if the logs are small or dry. Even when the capacity is used to the maximum, the chipping occurs partly in proximity to the centre of the disc and partly in proximity to the outer periphery. In view of the fact that the cutting process is less violent in proximity to the centre, a great deal of coarse fraction is produce in that area. On the outer periphery, instead, a large amount of fine fraction is produced due to the increase in the cutting speed. The cutting force in chipping in a vertical feed chipper and other factors relating to such chippers are described in patent application FI 973078.

The method and the disc chipper according to the invention make it possible to level down these kinds of differences in quality resulting from the chipping in different portions of the disc of the chipper and thus from the chipping at different cutting speeds. The characterising features of the invention are set forth in claims 1 and 4.

The method of producing chips of uniform quality levels out short-term differences in quality resulting from the constantly varying capacity, from the varying diameters of the logs or from the varying dry solids content of the logs. The method produces chips of more uniform quality despite the above-mentioned differences.

The invention and the details thereof will now be described in more detail with reference to the accompanying drawings in which

figure 1 shows the disc of a disc chipper and its cutting geometry viewed from the wood feeding side,

figure 2 shows the quality of chips as a function of cutting speed,

figure 3 is a view of section A – A of figure 1, during chipping,

figure 4 is a view of section A – A of figure 1, in a chipper having a traditional knife equipment,

figure 5 shows the quality of chips with different angles α of the front edge of the knife base,

figure 6 is a view of section B – B of the disc of the chipper shown in figure 1,

figure 7 is a view of a knife strip according to the invention and of sections C – C and E – E thereof, and

figure 8 shows a further method of compensating the cutting speed in the knife base.

Figure 1 shows the knife disc 1 of a disc chipper viewed from the wood feeding side. The figure shows also the opening 2 of the feeding chute of a vertical feed chipper which is fed by means of a feeding chute. The opening ends at the knife disc 1. The logs to be chipped form a cutting ellipse 3 against the knife disc 1. The knife disc 1 rotates at a given speed n. When the knives 4 perform chipping, the logs in the chute place themselves against the counter knife 5 at different distances from the centre of rotation 6 of the disc, depending on the number of the logs to be chipped, on the diameters and the dry solids content of the logs.

The cutting force in the direction of the cutting edge of the knife, and partly the "scissors force", of the knives move small logs 3' towards the inner periphery 7 of the opening. When it comes to small logs, the cutting force dominates compared with the "scissors force". When it comes to bigger logs 3", instead, the "scissors force" dominates and moves the logs having a large diameter towards the outer periphery 8 of the feeding opening. The cutting force moves dry wood more effectively because the friction coeffi-

cient between the knives and the wood is higher. When the capacity is at its maximum, the logs place themselves over the whole length of the counter knife, and so they are cut into pieces at different positions. For the aforementioned reasons various logs are chipped at different cutting speeds.

The higher the cutting speed, the more "violent" is the cutting process. It will be understood by those skilled in art that a greater cutting speed results in a decrease in the share of oversize and overthick fractions, i.e. in the share of coarse fractions, and in an increase in the share of sawdust and pin fractions, i.e. in the share of fine fractions.

Figure 2 illustrates the result of a test about the effect of the cutting speed on the distribution of the different kinds of chips. The x-axis and y-axis stand for the cutting speed and for the distribution of the different kinds of chips, respectively. The lowermost area and the uppermost area stand for the share of fine fractions and for the share of coarse fractions, respectively. The area between the lowermost and the uppermost areas stands for the share of the accepted fraction. According to the test, the amount of coarse fractions decreases from the level of about 13 % to the level of 4 % with a 50 % increase of the chipping speed. At the same time, it can be seen that the increase in the fine fractions is quite reasonable. When it comes to high-production disc chippers and to chipping in proximity to the shaft and towards the outer periphery, 1,5 is a very common chipping speed ratio, i.e. the speed ratio of the different cutting points of the knife. The ratio between the extreme values is even 1 to 3. If it is assumed that the highest chipping speed is 1, the minimum chipping speed is 0,3 and the general chipping speed is 0,5 – 0,75. Consequently, the chips produced by the chipper are not of uniform quality.

Figure 3 is a side view of a knife 4 and of the whole knife equipment of a disc chipper. Behind the knife there is a knife base 9 the front surface 10 of which the chips 11 hit after the cutting process. The knife cuts a disc-shaped slab from the log, the slab splitting into chips 11 already at the cutting stage. The chips hit the front face 10 of the knife base and as a result of this they split into smaller pieces and separate from each other. The angle in a vertical plane and between a straight line parallel to the rotational axis of the disc and the surface 10 of the knife base 9 facing the chip opening 12 is here called angle α. Correspondingly, the angle between the rear surface 15 of the knife and the surface 10 of the knife base is called angle β. When the angle α, and thus also the angle β, are bigger, the impact effect of the front surface 10 is less and the chipping process is less violent.

Figure 4 shows the knife equipment of a chipper of an older model. Between a knife 4' and a knife base 9' there is a knife backing 13 which the chips hit after the cutting process. The value of the angle α of the knife backing has often been negative in chippers according to the prior art. The angle α of the knife backing 13 shown in figure 4 is about -6° and the chip flow hits the front surface 10 of the knife backing violently.

Figure 5 illustrates the results of a test about the effect of the angle α on the quality of chips, the cutting speed being constant. In the figure the x-axis and the y-axis stand for the angle α and for the distribution of the different kinds of chips, respectively. The different areas stand for the different kinds of chips in the same way as in figure 2. As the angle α becomes smaller and the impact effect increases, the share of coarse fractions decreases considerably, whereas the share of fine fractions increases relatively less, until the zero value of the angle α. When the value of the angle α is negative, the share of fine fractions begins to increase more intensively. It is a well-known fact that the share of fine fractions is big with knife equipment of the same type as the one shown in figure 4.

From the foregoing it will be clear that the chipping speed and the angle α of the knife base (knife backing) have a significant effect on the chipping result. Furthermore it is clear that the chippers according to the prior art produce chips of first-rate quality only at a low chipping speed range and along a short portion of the knife.

As it appears from the description above, the variation in the chipping speed can be compensated for in practice by using knife base angles α of 0° – 20° if the speed range is 1 – 1,5. However, as the speed range of a chipper knife is much wider, it is necessary to perform the speed compensation in the knife portion at the inner periphery by placing the counter surface 10 closer to the cutting edge 16 of the knife.

In the method according to the invention, the effect of speed is compensated for by changing the angle α of the knife base from the inner periphery 7 to the outer periphery 8. Where the chipping speed is low, in other words at the inner periphery 7 of the feed opening, the value of the angle α of the knife base (knife backing) is small (figure 6, α_2) or even negative. Correspondingly, the value of the angle α is great where the chipping speed is high, in others words at the outer periphery 8 of the feed opening (figure 3, α_1). By changing the value of the angle α according to the distance from the rotating centre of the disc, the "violence" - which is due to differences in the chipping speed - of the chipping process can be maintained constant.

When using long chipper knives, where the angle α cannot compensate for the difference in speed, the counter surface 10 can be brought closer to the cutting edge 16 of the knife without changing the angle α_2. Thus, the shorter the distance to the shaft 6 of the chipper, the closer the surface 10 lies to the cutting edge of the knife.

When using a short knife and when the value of the angle α is 0° at the inner periphery, the share of coarse fraction can be made considerably smaller as the impact effect is increased. However, the amount of fine fractions remains reasonable due to the low chipping speed. Due to this, the relative share of accepted fraction in chipping at the inner periphery increases and the overall quality of the chips improves. When using the current values of the angle α (12° – 20°), the amount of coarse fractions produced at the outer periphery is reasonable due to higher chipping speed. The method produces chips of uniform quality irrespective of what portion of the knife is used for the chipping. Consequently, the effect of the capacity, of the different diameters or dry solids content of the logs is less on the quality of the chips.

In theory, functioning according to the invention can be achieved just by changing the distance D between the surface 10 and the knife edge 16. Because the construction of a chipper imposes certain limits on the change of the distance D and because the effect of this change is not so significant as the change of the angle α, the change of the distance D can be applied only to a short portion of the knife base or knife backing.

In practice, when using a long knife, the knife base or knife backing can be designed, as is shown in figure 7, so that the value of the angle α is 0° in the first quarter of the knife length, 0.25 L, (L = the length of the knife) from that end 14 of the knife base that is situated on the side of the shaft, and so that the angle obtains the value of +20° along the following half of the knife length (0.5 L). If the problem is the share of coarse fractions, the knife backing can be so designed that it approaches the knife edge 16 at the inner edge. In figure 7, the dashed line K stands for this. In figure 8, the same is shown in the knife base 9 so that the distance D is shorter than the one at the outer edge.

It is clear, that the knife base or knife backing according to the invention are constructed by using the above-mentioned combinations in such a way that the best possible quality of chips is obtained.

Claims

1. A method of chipping wood by means of a disc chipper provided with knives (4) so that the chips (11), after having separated from a log (3), pass through a chip opening (12) in the disc and hit an impact surface (10), which is located after a knife and the direction of which deviates from the direction of the rear surface (15) of the knife, with the result that the chips split into smaller pieces and separate from each other, **characterised** in that, in order to produce chips of uniform quality along all portions of the knife (4), a stronger impact effect is caused in proximity (7) to the centre of the disc (1) than in proximity (8) to the outer periphery of the disc by making the chips (11) hit an impact surface (10) whose direction in proximity (7) to the centre of the disc (1) deviates more from the direction of the rear surface (15) of the knife than in proximity (8) to the outer periphery of the disc, and/or by making the chips (11), before they hit the impact surface (10), pass further behind the rear surface (15) of the knife in proximity to the outer periphery (8) of the disc (1) than in proximity (7) to the centre of the disc.

2. A disc chipper including a plurality of knives (4) fastened to a rotating disc and a fixed counter knife (5), as well as, in the disc, adjacent to each rotating knife, an elongated chip opening (12), in which the direction of that wall (10) that joins the rear surface (15) of the knife deviates from the direction of the rear surface of the knife and forms an impact surface located after the knife, **characterised** in that the direction of the impact surface (10) deviates more from the direction of the rear surface (15) of the knife in proximity (7) to the centre of the disc than in proximity (8) to the outer periphery of the disc, and/or that the distance (D) of the connecting line between the rear surface (15) of the knife and the impact surface (10) from the cutting edge (16) of the knife is greater in proximity (8) to the outer periphery of the disc than in proximity (7) to the centre of the disc.

3. A disc chipper as defined in claim 2, **characterised** in that the angle between the impact surface (10) and the rear surface (15) of the knife changes about 20 degrees from the centre (7) of the disc to the outer periphery (8) of the disc.

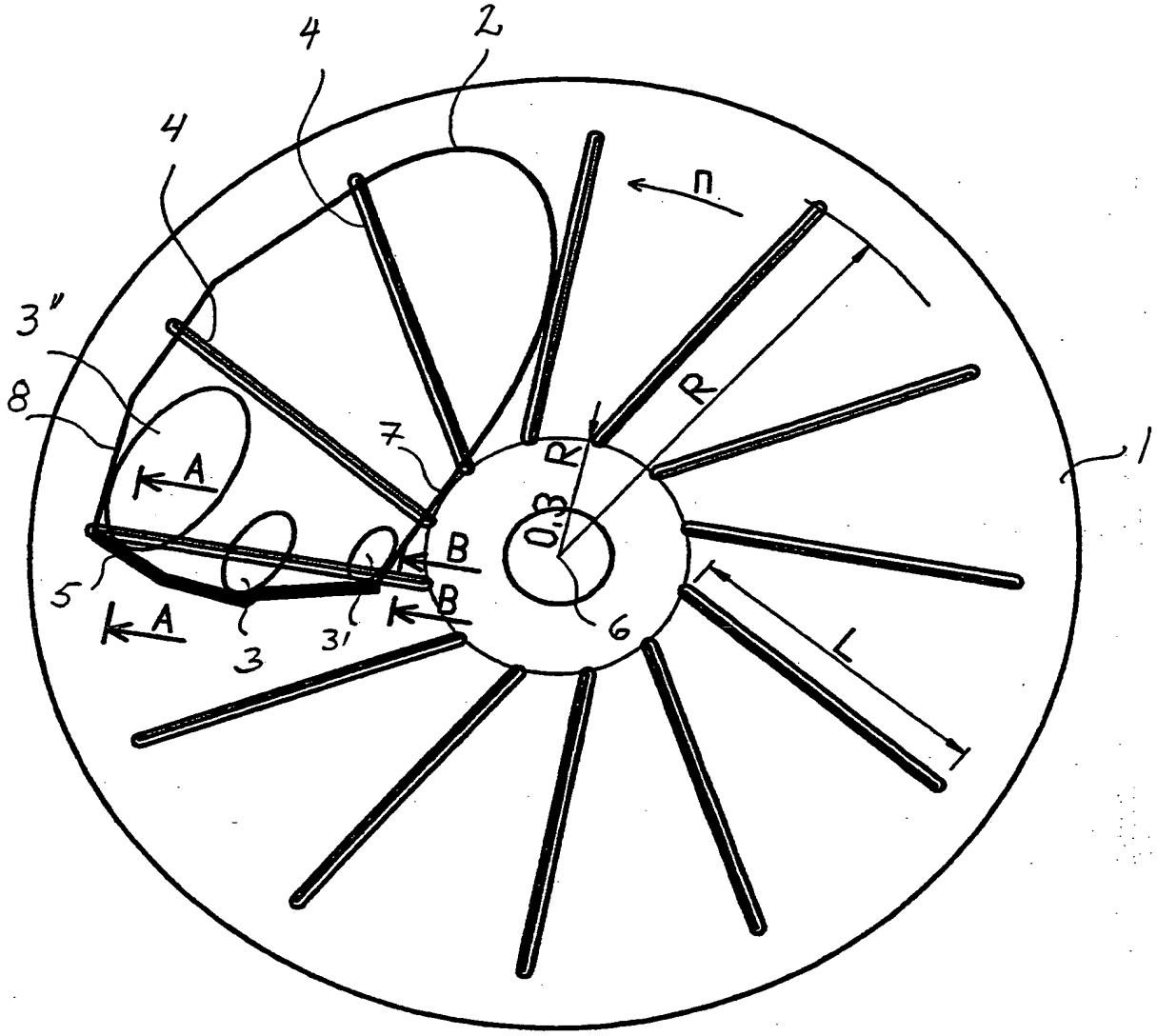


Fig. 1

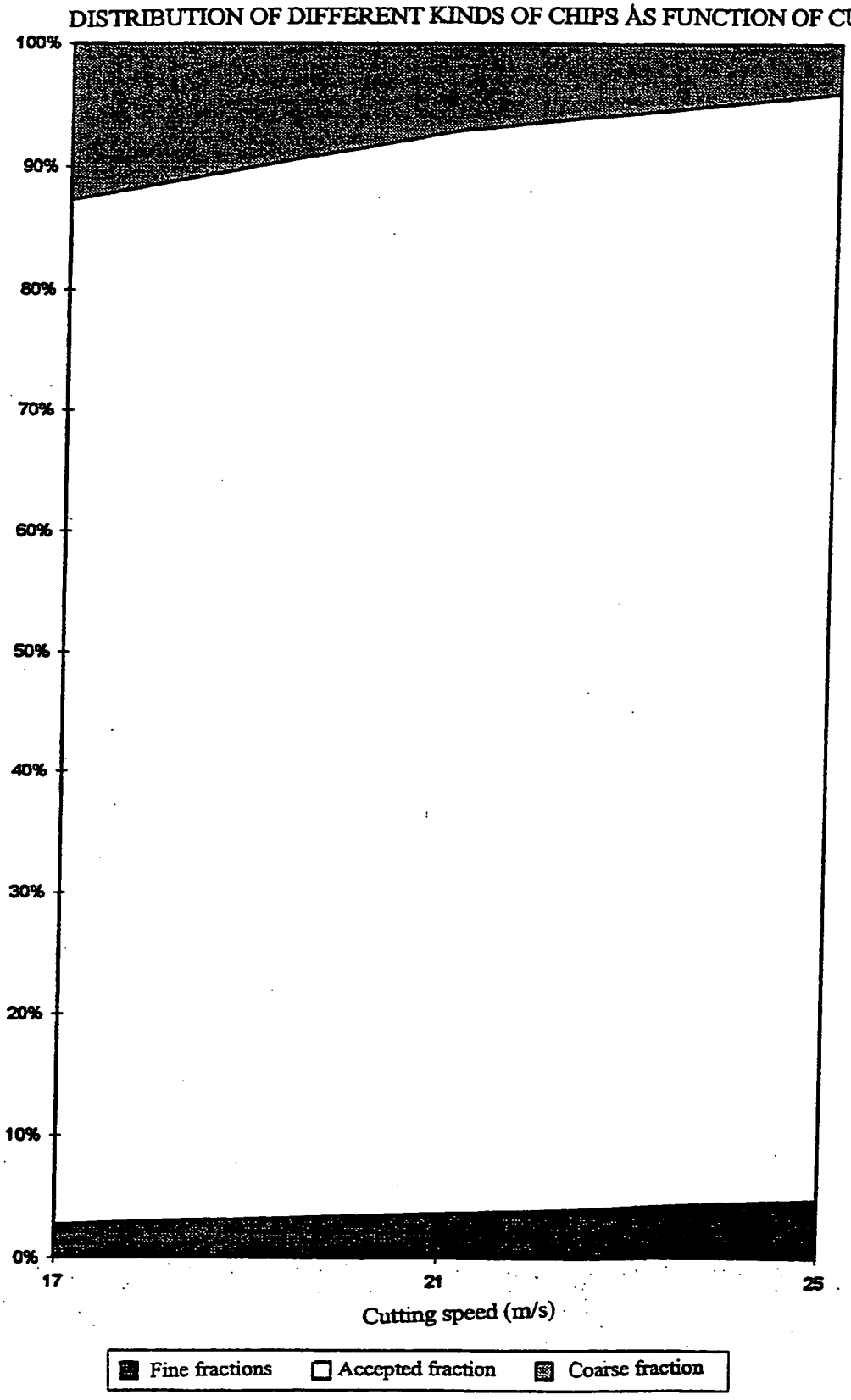

DISTRIBUTION OF DIFFERENT KINDS OF CHIPS AS FUNCTION OF CUTTING SPEED
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
17
21
25
Cutting speed (m/s)
Fine fractions
Accepted fraction
Coarse fraction

Fig. 2

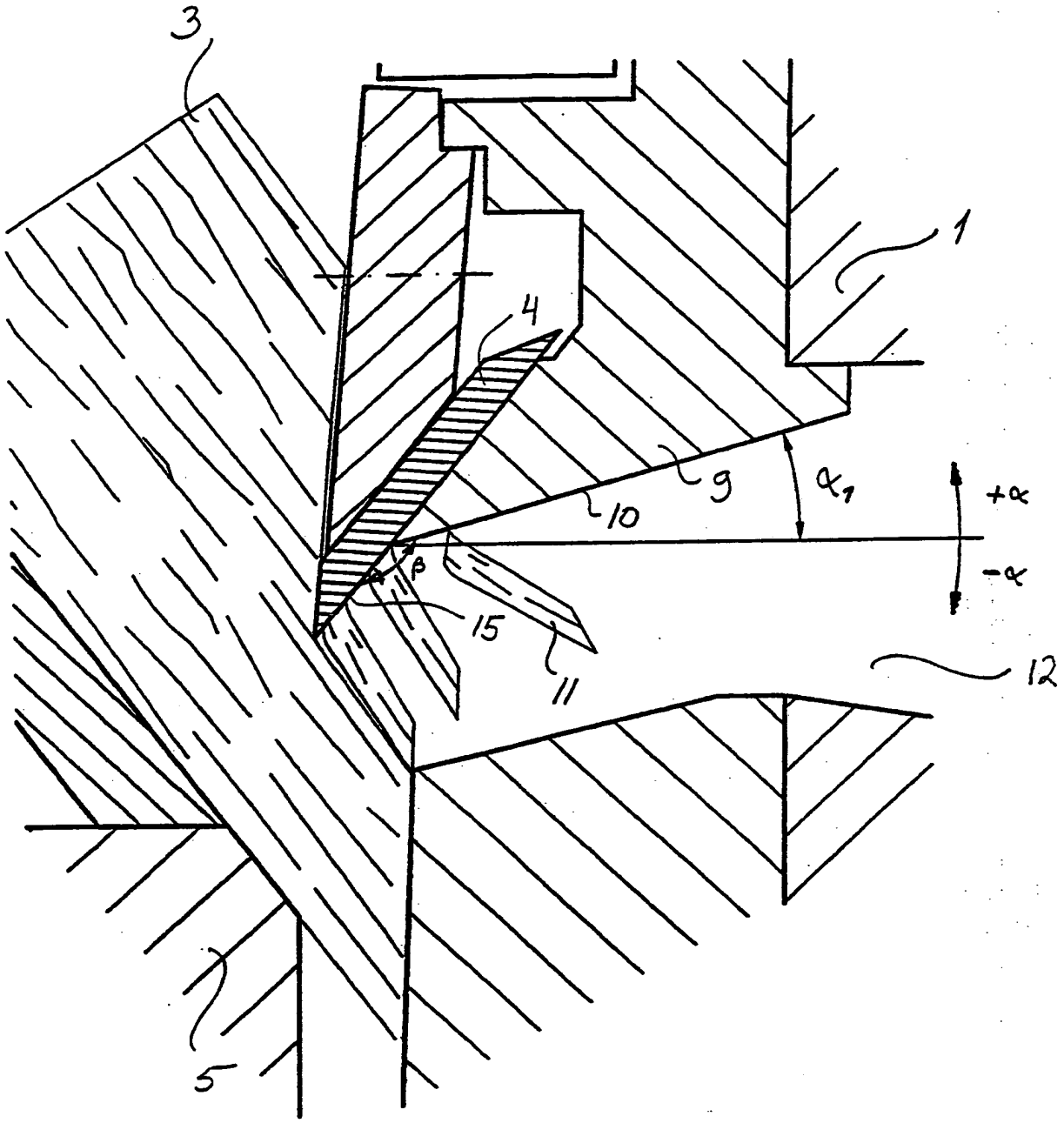


Fig. 3

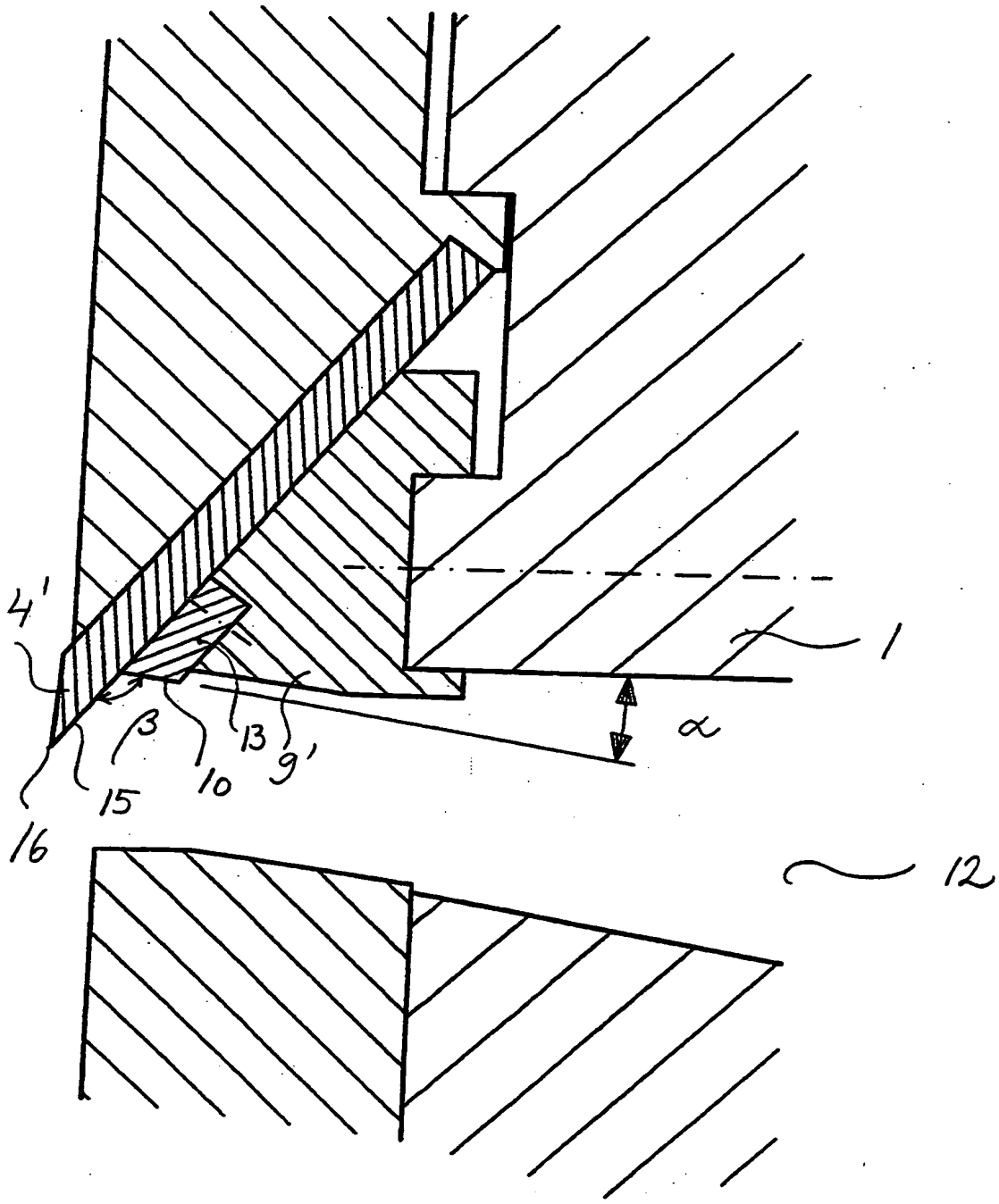


Fig. 4

DISTRIBUTION OF DIFFERENT KINDS OF CHIPS AS FUNCTION OF ANGLE ALFA

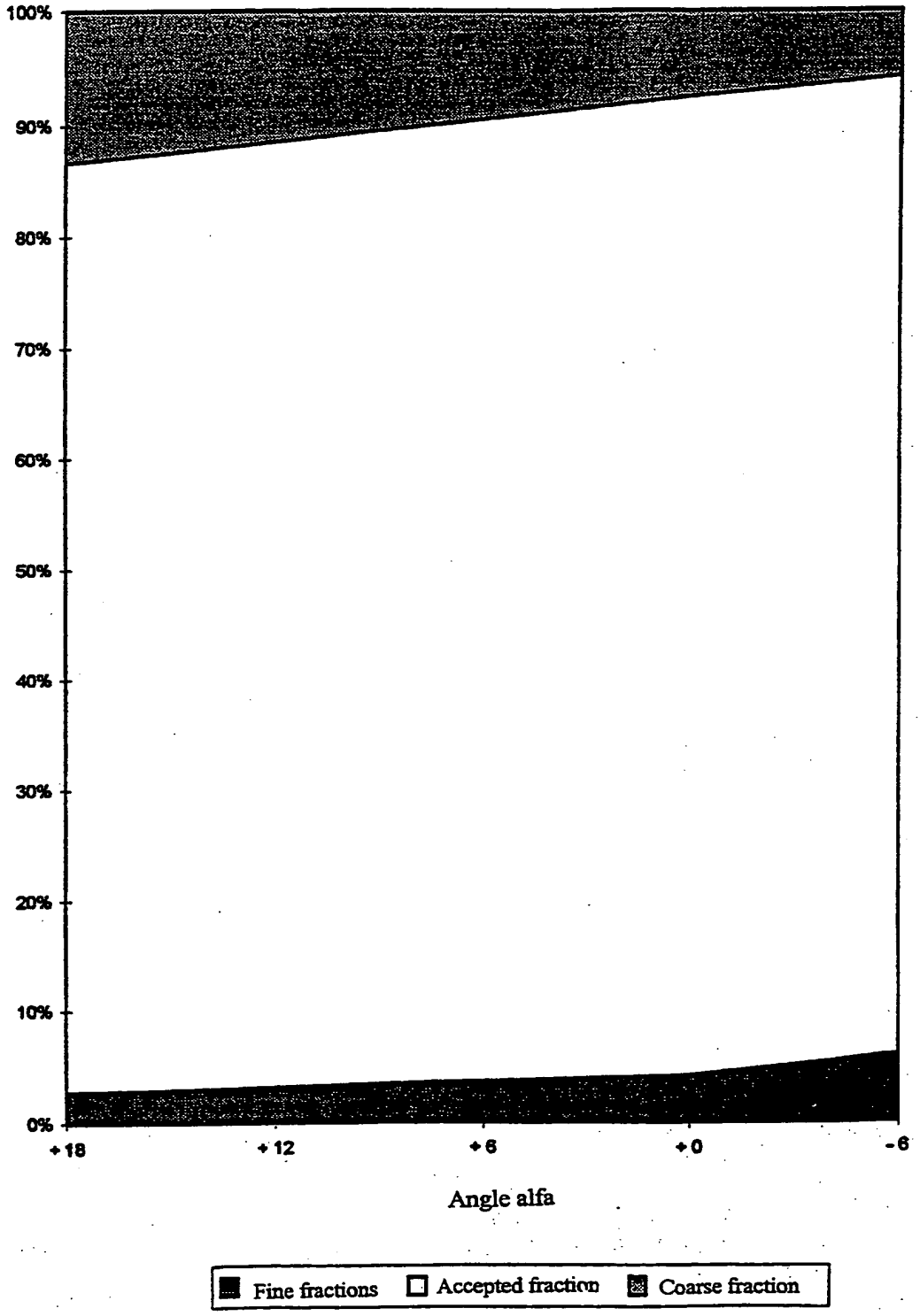


Fig. 5

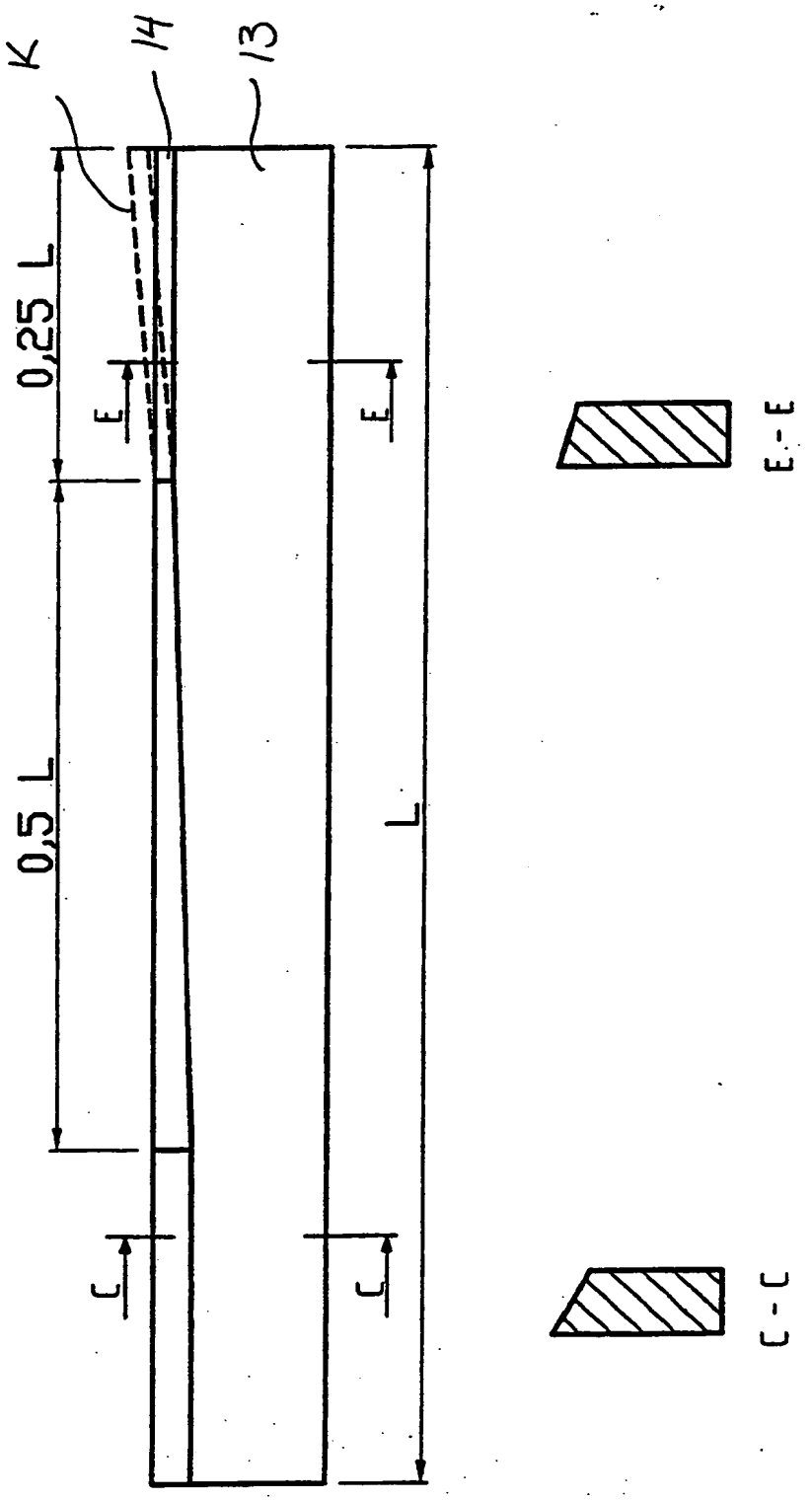


Fig. 7

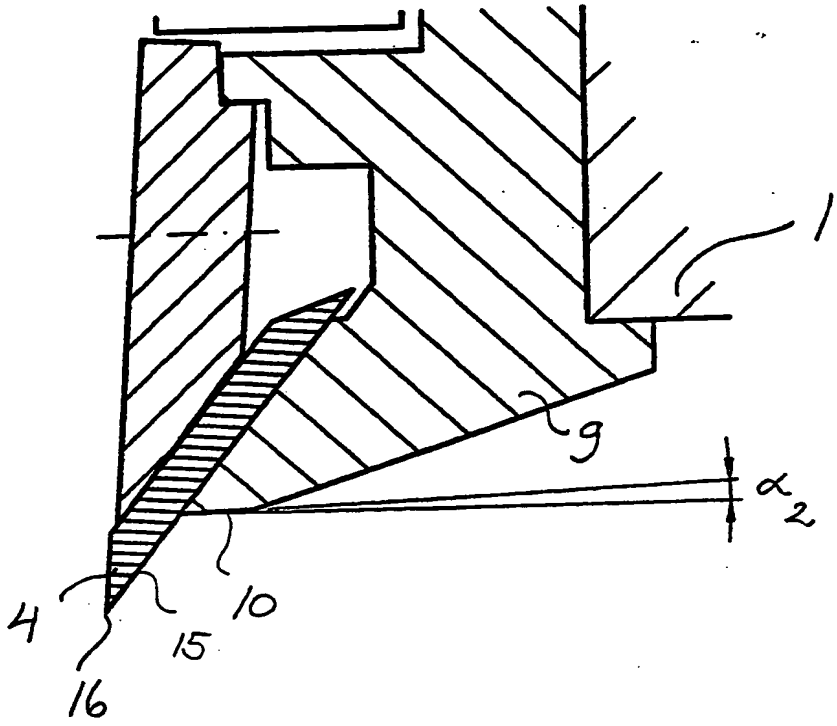


Fig. 6

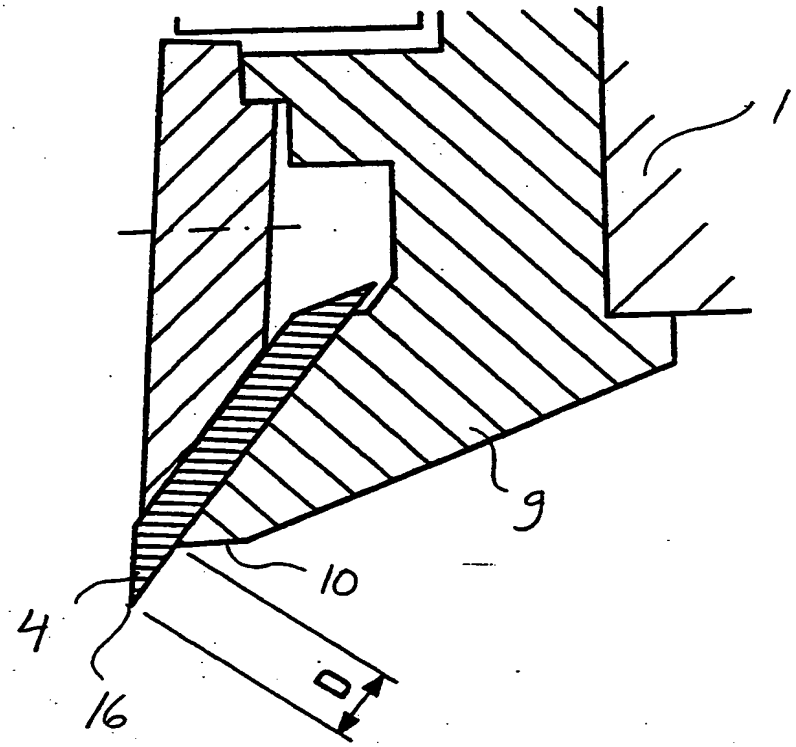


Fig. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 99/00376

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: B27L 11/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: B27L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, EPODOC, TXTE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3661329 A (SMITH ET AL), 9 May 1972 (09.05.72), column 2, line 66 - line 74; column 3, line 70 - column 4, line 10 --	1-3
A	US 3682400 A (SMITH), 8 August 1972 (08.08.72), column 3, line 58 - column 4, line 15 --	1-3
A	US 3905558 A (GAITTEN), 16 Sept 1975 (16.09.75), column 6, line 40 - line 46 --	1-3
A	US 5373876 A (TÄHKÄNEN ET AL), 20 December 1994 (20.12.94), column 1, line 36 - line 38; column 1, line 60 - line 63; column 3, line 16 - line 46 --	1-3

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 August 1999	24 -08- 1999
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Eddy Leopold Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 99/00376

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0911127 A2 (KEY KNIFE, INC.), 28 April 1999 (28.04.99) -- --------	1-3

INTERNATIONAL SEARCH REPORT

Information on patent family members

01/07/99

International application No.
PCT/FI 99/00376

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 3661329 A	09/05/72	NONE	
US 3682400 A	08/08/72	NONE	
US 3905558 A	16/09/75	CA 962921 A	18/02/75
		DE 2333538 A,B,C	04/04/74
		DK 134886 B,C	07/02/77
		SE 400211 B,C	20/03/78
US 5373876 A	20/12/94	CA 2107250 A	20/04/94
		FI 91946 B,C	31/05/94
		FI 924734 D	00/00/00
		SE 510477 C	25/05/99
		SE 9303403 A	20/04/94
EP 0911127 A2	28/04/99	US 5819826 A	13/10/98